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The purpose of the project was to acquire a variable temperature scanning tunneling microscope (STM) to be used for atomic level imaging of surfaces. After considering many possible instruments, we ordered an instrument from Omicron Corporation, a customized VT STM 25RH Special Instrument. This provides sample heating and cooling during STM operation. The instrument was finally delivered on July 20, 2001. The instrument is being set up and is undergoing tests at present.

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Final Report

A Proposal to Acquire a Variable Temperature Scanning Tunneling Microscope System

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I. Summary

The purpose of the project was to acquire a variable temperature scanning tunneling microscope (STM) to be used for atomic level imaging of surfaces. After considering many possible instruments, we ordered an instrument from Omicron Corporation, a customized VT STM 25RH Special Instrument. This provides sample heating and cooling during STM operation. The instrument was finally delivered on July 20, 2001. The instrument is being set up and is undergoing tests at present.

II. Characteristics of instrument purchased from Omicron:

Customized VT STM Configuration (Order Code B999912)

Item 1: VT STM 25 RH Special
Variable Temperature UHV STM for sample cooling and heating during STM operation. The microscope is equipped with helium/liquid nitrogen flow cryostat and resistive indirect sample heating facilities for sample temperatures from 50 K to 500 K. Three (3)-axis piezo driven coarse movement, single tube scanner (12 μm x 12 μm x 1.5 μm), remote controlled tip exchange, in-UHV hybrid I/V-converter.
consisting of:

Flange mounted VT STM Special for LHe/LN2 cooling
VT STM Bolt-on module special mounted on a base flange NW 200 CF (10" OD), including spring suspension with eddy current damping, feedthroughs, 10 mm x 10 mm x 10 mm tip coarse positioning range, complete wiring for STM operation. Sample stage with integrated PBN solid state heating element for indirect resistive sample heating and temperature sensor (type "K" thermo-couple) to measure the sample temperature. For cooling a LHe flow cryostat is integrated with thermal coupling to sample stage using copper braid. A flexible pumping line and a gas flow control block for the exhaust side of the flow.

STM preamplifier VT PRE U and cable set
STM preamplifier consisting of high-voltage differential preamp stage for use with head-integrated hybrid I/V-converter , with 12-pin plug for FT 12 UHV feedthrough and piezo cable set PIC 2. Temperature control cable set for use with heater controller HC 600 and for temperature measurement with type K thermocouple, with 6-pin plug for UHV feedthrough (5 m).

Set of tips, samples and accessories
Consisting of 10 premounted tunneling tips, 50 tip holders, 5 tip transfer plates, set of standard sample plates and test sample.

Roughing pump for use with LHe cryostat
Including flexible pumping line and excess pressure valve.

LHe transfer tube
Standard LHe transfer tube, U shaped, with dosing valve to connect to the liquid helium Dewar (Dewar not included). Dimensions: see data sheet: LHe transfer tube.

Item 2: Bolt-on extension for VT SPM (Order Code B001478)
Bolt-on extension for integration of VT SPM head to an UHV system.
consisting of:

VT SPM chamber with carousel and accessories for WS 180 (Order Code B000180)
UHV bolt-on chamber including viewports, sample and tip carousel with 12 storage positions.

WS 180 pincer grip wobble stick (Order Code B000178)
Pincer grip wobble stick, 180 mm travel, for sample and tip/cantilever transfer, 90 of axis pincer action, mounted on a NW 35 CF (2_" OD) flange (requires widened ID for 2 _" OD port).

CCD camera, light source and monitor (Order Code B000326)
CCD camera with light source, macro zoom lens and 9" b/w monitor for monitoring the tip approach.

Item 3: SCALA SPM control system (Order Code B000782)
Control electronics and software for data acquisition and processing with STM mode only. Upgradeable for AFM operation and for sample heating.
consisting of:

SPM control unit (Order Code B000759)
Modular control unit for STM, upgradeable for AFM operation, including the following slot cards: Real-time Measurement Controller (single board computer with MC68040 processor)

with High Performance Serial Bus (IEEE 1394), computer control by macro command language. Coarse positioning board for piezo inertia drives. VectorScan Generator with full area offset and scan width control. Six-channel piezo driver for tube scanner. Digitally controlled analogue feedback loop for STM or AFM operation. 16 bit D/A converters for gap voltage, tunneling current set point, and Z-offset. TwinAD board for simultaneous two-channel 16-bit data acquisition.

Windows NT computer (Order Code B001275)
Preconfigured Personal computer with high performance serial bus IEEE 1394 for data acquisition with OMICRON SPM Control Unit; Processor specifications to current standard. Minimum hardware configuration: 128 MB RAM, 8 GB hard disk, CD-RW drive, 3.5" floppy

disk drive, Ethernet, keyboard, mouse. Windows NT workstation and Drivers installed.

21" monitor for SCALA (Order Code B001276)

SCALA PRO (Order Code B000774)
Software package for SPM imaging, spectroscopy and nanolithography with OMICRON SPM hardware and simultaneous data analysis and image processing. The software runs on a Personal Computer under Windows NT or Windows 95. Data acquisition requires an OMICRON supplied Windows NT Computer. Included are an IDL runtime environment and a single user runtime license of the OMICRON application software and IDL. Software release updates, at least once a year, will be offered for the OMICRON application software and the IDL environment (free of charge for two years after delivery).

Item 4: HC 600 resistive heating power supply(Order Code B000193)
Upgrade of SCALA SPM control unit for resistive sample heating.

Item 5: Temperature controller for flow cryostat (Order Code B000190)
Electronic temperature controller with two input stages for the Silicon diode temperature sensors (one for cryostat regulation, one for monitoring the temperature of sample stage), PID control function, autotuning algorithm, IEEE-488 and a RS-232 interface. Temperature control cable set and counter heating cable are included.

Item 6: Resistive sample heating facility (RH 1 C) (Order Code B001329)
Mounted to sample holder for primary rotation (D = 9.5 mm).

Item7: Upgrade for direct current heating (Order Code B001331)
Mounting kit including molybdenum contact brush for upgrade of sample holders with resistive heating for direct current heating using sample plates for direct sample heating.

Item 8: Sample transfer head (Order Code B001333)
For OMICRON standard sample plates, for magnetically coupled transfer with linear and rotational motion (D = 19 mm).